

Enhancing South Africa's Emerging Digital Technologies' Innovation Ecosystem

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Key Messages

South Africa is a rising powerhouse of research, innovation and use of emerging digital technologies, including artificial intelligence (AI), blockchain, geographic information systems (GIS), internet-of-things (IoT), and new-generation data analytics.

South Africa is at the growth stage of its emerging digital technology (EDT) innovation ecosystem with a growing set of dedicated education programmes, an expanding research and innovation environment and a vibrant private sector utilising these technologies.

To ensure movement from growth to maturity of the EDT ecosystem, South African policymakers need to intensify efforts to bridge the skills and capabilities gaps through more advertising of existing education and training opportunities and increased dedicated EDT-related funding programmes. The continued movement towards an agile regulatory environment and stronger engagement with recognition of the needs of different, end users are also required.

Background

South Africa is ranked the top innovating mainland country on the African continent in the 2022 Global Innovation Index (GII) (WIPO, 2023). It has the second highest level of funding towards research and development on the continent (currently at 62% behind Kenya at 69% of GDP) (World Bank, 2022) with over 50% of the R&D funds coming from the government as opposed to foreign actors as in many other African countries. The private sector contributes around 23% of R&D spend (DSI, 2023).

The country has a vibrant start-up culture and a strong history of support for new market entrants through venture capital. One of the reasons the country ranks so highly in the GI is because it has three of the top ten highest valued venture capital (VC) deals on the continent in 2021.

A significant number of VC deals in South Africa in recent years have taken place in the FinTech space. For example, JUMO, a South African-based FinTech firm, raised US\$ 120 million in 2021 following a successful round of funding that raised US\$ 55 million the year before (Kene-Okafor, 2021).

JUMO uses artificial intelligence (AI) to power its 'banking-as-a-service' platform. AI is one of a suite of emerging digital technologies (EDTs) that are starting to transform the innovation space on the African continent. Other EDTs include blockchain, geographic information systems (GIS), internet-of-things (IoT), and new-generation data analytics. We term these new data analytics tools collectively as X-data. This encompasses big data, open data, user-generated data, and real-time data.

As more and more companies start to embrace these EDTs, the innovation ecosystem or facilitatory environment needs to be ready to support them. This is important if South Africa is to achieve its national development goals and remain a leading economic light on the African continent.

This policy brief outlines the results of a study into the status of the EDT innovation ecosystem in South Africa. It is part of a comparative study reviewing the status of the EDT innovation ecosystems in South Africa and Kenya. The policy brief findings are of value to those working in the EDT innovation ecosystem, especially those providing policy support in the areas of education, regulation and finance.

Methodology

An in-depth literature review and a review of the policy and regulatory environment were carried out. This was followed by a survey of stakeholders working in the EDT space in South Africa. From the gathered information, an assessment of the maturity of the EDT ecosystem in South Africa was performed, and policy recommendations were made. The literature review followed a multi-vocal systematic approach (Ogawa and Malen, 1991; Garousi, Felderer, and Mantyla, 2016) of both peer-reviewed academic articles and grey literature covering the development and use of EDTs in South Africa. The grey literature reviewed focussed on reports, trade journals and technical articles, books and book chapters. Academic literature was reviewed using Google Scholar and Scopus using a range of relevant keywords and their combinations. This study builds on the results of an early report that looked at emerging technologies in South Africa more broadly (UJ-TRCTI, 2022).

Maturity or development stage models of an ecosystem provide tools for assessment of where an ecosystem or facilitatory environment is in its life cycle. These models enable the provision of insights into the current levels of recognised success factors essential for the maturity, health, and sustainability of the ecosystem. The EDT ecosystem maturity model, developed by Ogot et al. (2023) was used for this study. It is based on the five fundamental activities of the innovation processes framework (Liu and White, 2001): education, research (basic, developmental, engineering), implementation (manufacturing, deployment), end-use (customers of the product or process), linkages (bringing together complementary knowledge) and secondary actors (those providing relevant support functions to the main actors in the education, research and implementation space).

The emerging technologies maturity model defines three developmental stages. The ideation stage is beyond basic research, testing fundamental principles and is characterised by R&D activities with pilots and proof-of-concepts performed on potential commercial applications. The nascent stage embodies the early development and formation of the ecosystem. Finally, in the growth stage, the commercial applications of the technology start gaining strong acceptance in the market with increased demand and new

entrants; and the ecosystem governance structures are becoming clearer.

Results

The study found that South Africa is squarely at the **Growth stage** of the EDT innovation ecosystem maturity model. It has a growing education sector in this

space, a relatively mature research and implementation space, and a strong range of stakeholders involved and providing a facilitatory environment. That said, the technologies are still emerging, and there is no evidence of their embeddedness yet within the economy and society. This results from a skills and

finance gap together with an inadequate acknowledgement of the needs and requirements of different types of end users. Moves towards more facilitatory and agile regulation must continue together with a stronger focus on skills training, especially outside of the university system. Further details are provided in Table 1.

Table 1: Maturity of the different stages in the EDTs ecosystem

Fundamental Activities / Stage	Remarks
Education Growth	<ul style="list-style-type: none"> More than 10 universities offer post-graduate programmes in AI and data analytics-related subjects. Technical Vocational Education and Training (TVET) institutions and Sector Education Training Authorities (SETAs) are embracing technology programmes focusing on the Fourth Industrial Revolution or 4IR. The school-age education curriculum now has coding and robotics included in them. There are, however, still skills gaps and concerns about the employability of graduates.
Research Growth	<ul style="list-style-type: none"> AI and X-data research is taking place in multiple sectors. Several collaborative research centres exist. Some have been set up since 2011 while others were set up after the publication of the South African Presidential Commission on the 4IR (PC4IR) reported in 2019. Four research chairs on AI and related areas are being funded by the South African government. South Africa has more patents and publications than any other African country, but the numbers are still low in comparison to other emerging economies in the Global South. Challenges facing researchers and innovators relate to access to big data sets, keeping up with the rapid developments in the sector and funding.
End use Growth	<ul style="list-style-type: none"> The country has higher than average African internet penetration rates at 72% and significantly higher than the global average for hours connected to the internet per day. Challenges affecting some end-users include infrastructure inadequacies associated with Wi-Fi coverage and highly expensive data. This is further complicated by a lack of adequate equipment that accommodates the amount of data received or produced. Some users have negative perceptions of EDTs linked to security and privacy concerns limiting the use of opportunities presented by EDTs. Some issues relate to difficulties and complexities in changing organisational culture to digital options and the fear of disruption to existing jobs.
Linkages Growth	<ul style="list-style-type: none"> Increasing numbers of partnerships between researchers and others both inside South Africa and with organisations outside of the country. Several public-private partnerships exist focusing on EDTs, X-Data and/or related technologies. Several industry associations and researcher networks have been set up to coalesce research and practice in AI and data analytics in South Africa. <ul style="list-style-type: none"> High levels of interest in this area of research and innovation have remained since the PC4IR was set up.
Implementation Growth	<ul style="list-style-type: none"> AI and data analytics are used across a range of organisations, especially by the private sector (large and small firms). Government agencies also utilise these technologies. Multiple sectors use these technologies ranging from insurance and customer services through to health and agriculture. Allied government agencies actively support AI and related areas, e.g., through the National Digital Strategy. South Africa has traditionally had a top-down government-dominated regulation model but movement towards agile and facilitatory governance examples are now visible including anticipatory regulation and outcome-based approaches. Funding is available through government but also private firms receiving venture capital support at an early stage, including from some South African-based VC firms.

Identified Challenges

- There will be a skills and capabilities gap until the new curriculum changes take effect
- Access to big data sets is limited
- Researchers and innovators struggle to keep up with rapid technological developments
- Funding is better than in other countries but is still limited, including for infrastructure upkeep
- Only a few examples of agile regulation
- Limited interaction with users in the innovation ecosystem

Policy Recommendations

- Intensification of efforts to bridge the skills and capabilities gaps is needed. This requires both more advertising of the existing courses and programmes that are available now as well as dedicated funding of scholarships for these courses and programmes.
- Mobilise existing or new networks of researchers to gain access to datasets and enhance training on data mining/ data scraping. In addition, increase networking between EDT researchers and those working on Open Science efforts in South Africa.

- The country's National Research Foundation (NRF) and others to provide dedicated spaces for information sharing.
- The NRF and the country's Technological Innovation Agency (TIA) need to introduce more dedicated funding streams for EDT-related research and commercialisation efforts.
- Build on the efforts already undertaken to increase the levels of agile regulation. This requires more information sharing and multi-stakeholder engagement as well as cross-ministry activity.
- Recognise the needs and requirements of different types of users within the innovation ecosystem, notably the difference between professional and end

users. Set up multi-stakeholder engagement platforms dedicated to sharing information and networking opportunities for those working in different EDT-related spaces.

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References

DSI. (2023). Survey Shows That High Proportion Of R&D Funding Comes from Government. [https://www.dst.gov.za/index.php/media-room/latest-news/3857-survey-shows-that-high-proportion-of-r-d-funding-comes-from-government#:~:text=The%20government%20sector%20\(including%20science,main%20beneficiaries%20of%20government%20funding.](https://www.dst.gov.za/index.php/media-room/latest-news/3857-survey-shows-that-high-proportion-of-r-d-funding-comes-from-government#:~:text=The%20government%20sector%20(including%20science,main%20beneficiaries%20of%20government%20funding.) Accessed: 12 August 2023.

Garousi, V., Felderer M., and Mäntylä, M. (2016). 'The Need For Multivocal

Literature Reviews in Software Engineering: Complementing Systematic Literature Reviews With Grey Literature', *20th International Conference on Evaluation and Assessment in Software Engineering, Limerick, Ireland, 01-03 June.*

Kene-Okafor, T. (2021). Fidelity, Visa and Kingsway back South African fintech JUMO in \$120M round. <https://techcrunch.com/2021/11/08/fidelity-visa-and-kingsway-back-south-african-fintech-jumo-in-120m-round/>. Accessed: 12 August 2023.

Liu, X and White, S., (2001), "Comparing innovation systems: a framework and application to China's transitional context", *Research Policy*, 30: 1091-114.

Ogawa, R. T., and Malen, B. (1991), "Towards Rigor in Review of Multivocal Literatures. Applying the Exploratory Case Study Method", *Review of Educational Research*, 61, (3): 265-286.

Ogot, M. et al. (2023) *Emerging Technologies in Kenya – A Landscape Analysis: Final Report*. Nairobi: University of Nairobi.

The World Bank, 2022. Research and Development Expenditure (% of GDP) – Sub-Saharan Africa. <https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?locations=ZG>. Accessed: 12 August 2023.

UJ-TRCTI. (2022). *Emerging Technologies in South Africa: A Landscape Analysis*. Johannesburg: UJ-TRCTI.

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